CLAIMS

What is claimed is:

1. An apparatus comprising:

an electronics chip having a substrate with a first face thereof having circuitry thereon, and an opposite second face; and

one or more electro-osmotic pumps in a layer over the second face.

2. The apparatus of claim 1, wherein the electro-osmotic pumps include capillary pump channels in a further layer over the second face of the electronics chip.

3. The apparatus of claim 2, wherein cooling channels are formed in a further layer over the second face of the electronics chip in fluid communication with the electro-osmotic pumps.

4. The apparatus of claim 3, wherein external fluid connections to the pumps are made at lateral edges of the apparatus.

5. The apparatus of claim 1, wherein electrical power for the electro-osmotic pumps is conducted by electrical conductors formed through the electronics chip.

6. The apparatus of claim 2, wherein cooling channels are formed in a further layer of material over the second face of the electronics chip, and the electro-osmotic pumps are in fluid communication with the cooling channels.

7. The apparatus of claim 6, wherein external fluid connections to the pumps are made at lateral edges of the apparatus.

8. The apparatus of claim 6, wherein electrical power for the electro-osmotic pumps is conducted by electrical conductors through the electronics chip to the pumps.

9. The apparatus of claim 1, wherein the cooling channels are formed in the same layer as the capillary pump channels.

10. The apparatus of claim 1, wherein the electronics chip is silicon, cooling channels are formed in a layer of silicon over the second face of the electronics chip, and the electro-osmotic pumps are formed in a further layer of silicon over the second face of the silicon chip in fluid communication with the cooling channels.

11. The apparatus of claim 10, wherein external fluid connections are made at lateral edges of the apparatus.

12. The apparatus of claim 10, wherein electrical power for the electro-osmotic pumps is conducted by electrical conductors formed through the electronics chip.

13. The apparatus of claim 1, wherein the chip is made of silicon, and the electro-osmotic pumps include capillary pump channels formed in a layer of silicon over the second face of the chip.

14. The apparatus of claim 1, wherein the chip includes circuitry for at least a portion of a processor, the apparatus further comprising:

a memory operatively coupled to the processor;

an input/output system, including a display unit, operatively coupled to the processor; and

a power supply operatively coupled to the processor.

15. The apparatus of claim 1, wherein the chip includes circuitry for at least a portion of a telecommunications circuit, the apparatus further comprising:

an antenna operatively coupled to the telecommunications circuit;

an input/output system, including a display unit, operatively coupled to the telecommunications circuit; and

a power supply operatively coupled to the telecommunications circuit.

16. A method for cooling an electronics chip on a substrate with a first face thereof having circuitry thereon, and an opposite second face, the method comprising:

pumping a cooling fluid thermally coupled to the second face with one or more electro-osmotic pumps positioned over the second face.

17. The method of claim 16, wherein the electro-osmotic pumps include capillary channels in a layer of material over the second face of the electronics chip, and wherein the pumping includes electroosmotically flowing the cooling fluid in the capillary channels.

18. The method of claim 16, further comprising:

flowing the cooling fluid through external fluid connections at lateral edges of the electronics chip and the layer containing the electro-osmotic pumps.

19. The method of claim 16, further comprising:

conducting electrical power for the electro-osmotic pumps through electrical conductors passing through the electronics chip.

20. A method comprising:

providing an electronics chip having a substrate with a first face having circuitry thereon, and an opposite second face; and

providing at least one layer of material over the second face, one of the at least one layers forming at least one electro-osmotic pump.

21. The method of claim 20, further comprising:

forming cooling channels in one of the at least one layers of material over the second face of the electronics chip, the channels operatively coupled to one of the at least one electro-osmotic pumps.

22. The method of claim 21, further comprising:

attaching a handle layer to the first face of the electronics chip; and

thinning the electronics chip by polishing and/or etching the second face of the electronics chip.

23. The method of claim 22, further comprising:

forming electrical conductors through the electronics chip, for supplying electrical power to the electro-osmotic pumps.

24. The method of claim 23, wherein the chip is made of silicon, and the layer silicon over the second face of the circuit die is attached to the silicon chip.

25. The method of claim 23, further comprising:

packaging the electronics chip into a package;

mounting the package onto a circuit board having other circuitry; and

coupling the packaged electronics chip to supply of fluid to the electro-osmotic pump.

26. An apparatus comprising:

an electronics chip; and

an electro-osmotic pump for circulating cooling fluid through cooling channels adjacent a face of the chip.

27. The apparatus of claim 26, wherein the electro-osmotic pump and the cooling channel are in separate layers of material attached to the face of the chip..

28. The apparatus of claim 27, wherein the electro-osmotic pump and the cooling channel are in the same layer of material.

29. The apparatus of claim 28, wherein the electro-osmotic pumping means and the cooling channel are in substantially the same plane.